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Interstate Natural Gas Association of America

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Public Education

• Pipeline Construction

Project Planning

Project planning begins with the basics of supply and demand. If there is a need for natural gas, conduct a **market analysis** to estimate the size of the market. This gas supply requirement is in terms of million cubic feet of gas per day. With this information engineers can begin to estimate transport the required volumes of gas, including the basic design parameters of pipeline diameter, thickness and the cost to construct the pipeline facilities.

Design

The **size** of interstate pipelines varies, but in most cases a mainline, the major principal or main line, be in the range of 16 to 48 inches in diameter. Laterals, which are smaller diameter pipelines that branch off the mainline or take gas from the mainline, typically are 6 to 16 inches in diameter.

The exact diameter of a pipeline and the gas it is designed to deliver is determined by the gas volume to be delivered - which the pipeline company will be operated. In order to meet customer delivery requirements, interstate pipelines operate at a pressure of at least 600 pounds per square inch (psi), typically about 1,000 psi.

The **wall thickness** of the pipeline is determined by the maximum operating pressure (MAOP), published industry standards and federal regulations. The pipeline incorporates a design safety factor. The pipeline must also meet DOT's federal regulations, that is related to the type of construction and population density along the route.

Engineers initially identify preliminary pipeline routes that will minimize impact to the public, public lands, and the environment. The pipeline company, typically will go through a process of reviewing available maps, aerial photography, and available published environmental data to determine a number of possible alternative routes. This desktop work will then be augmented by use of aerial and ground surveys to identify and select a preferred route.

Once a preferred route is identified, the pipeline company will begin contacting landowners to discuss the project and seek permission to conduct civil and environmental surveys. These surveys are required for use in the detailed pipeline design and for preparing local, state and federal permit applications. Even though pipeline officials may begin discussions with landowners at this point, it is important to remember that the project is undergoing a feasibility analysis, and neither the project nor the pipeline route is finalized at this time. Selecting a pipeline route often involves discussing and evaluating options with landowners, environmental agencies and regulatory officials. If the market analysis ultimately justifies the cost of pipeline construction, only then will the pipeline company begin seeking permits and preparing a detailed project application for the Federal Energy Regulatory Commission ([FERC](#)).

Permits

Prior to construction, a pipeline company must obtain numerous local, state and federal permits. These permits address all of our natural resources--land, air, water, vegetation and wildlife, as well as the general public. The requirements vary with the specific project, but some of the typical permits are:

Local

- Building, road crossing permits
- Road crossing permits

State

- Land (Erosion and Sedimentation Permit)
- Water (Hydrostatic Testwater Acquisition and Discharge Permit, Stormwater Discharge Permit)
- Stream and River Crossings (State Environmental Agency)
- Cultural Resources Preservation (State Historic Preservation Office)
- Threatened and Endangered Species Preservation (State Fish & Wildlife Agency)
- Air Emissions (State Environmental Agency)
- Noise (State Environmental Agency)

Federal

- Wetlands Preservation and Crossings (U.S. Army Corps of Engineers)
- Streams and Rivers (U.S. Army Corps of Engineers)
- Threatened and Endangered Species (U.S. Fish & Wildlife Agency)
- Air Emissions (U.S. Environmental Protection Agency)
- Environmental Resource Reports

Copies of all permits and permit applications are submitted to the FERC with the project filing.

FERC Filing

In order to get an interstate gas pipeline approved for construction, the pipeline company must file a detailed project plan with the (FERC). Among other things this plan includes maps showing the preliminary pipeline route, a description of the proposed pipeline facilities, and up to 12, specific environmental resource reports. These resource reports cover topics such as water use and quality, vegetation and wildlife, cultural resources, socio-economics, geological resources, soils, land use, air and noise quality and project alternatives. A copy of the company's application may be obtained from the FERC's Public Reference Room (202-208-1371) for a nominal fee though they are usually made available at local public places such as libraries in the area through which the pipeline will traverse.



The FERC has the authority to approve the pipeline location and construction. It does so through Certificate of Public Convenience and Necessity (Certificate). Before the commission will authorize however, it thoroughly reviews the project to determine if it is in the public interest. This review includes need for the project, costs of transporting natural gas by the pipeline, financing and market competition. The commission also conducts an Environmental Assessment or an Environmental Impact Study to evaluate the impact on the public and the environment.

Part of the Commission's review process includes public meetings in the communities to be affected. Announcements of these public meetings are published in local newspapers. The meetings allow the local community to ask questions and express any comments or concerns about the project.

The time required for the review process varies based on the size of the project, but typically it takes from the time a company submits an application until the Commission renders their decision as to whether to approve a certificate for a project. Once the certificate is issued, the commission will authorize construction when the conditions they established in their order issuing the certificate are satisfied.

For information, the Process is generally as follows:

1. File Application
2. Public meeting in about 6-8 weeks

3. Review application
4. Issue a P.D.
5. Issue DEIS
6. Another round of public meetings
7. Issue FEIS
8. Issue/deny certificate

Acquisition of Rights of Way

The acquisition of a pipeline right-of-way often raises many questions with landowners - "Why is this the route for the pipeline? Why is the pipeline needed? What is the procedure for acquiring approval for use of my land? How will I be compensated? How will the land be restored after construction? Can I use the land after the pipeline is installed?"



To answer those questions, let us look first at the process. The cornerstone of the right-of-way acquisition process is the negotiation of an Easement Agreement. This agreement covers key issues such as compensation, restoration of the land and restrictions on future use of the land. Once the pipeline route is selected, a right-of-way agent from the pipeline company will contact each affected landowner along the route to discuss the project and negotiate an easement agreement.

In addition to a permanent easement the company requires to operate and maintain its pipeline after it is constructed, the company also requires a temporary easement during construction. The permanent easement typically is about 50 feet wide and the temporary easement typically will range between an additional 50 to 75 feet depending on the size of pipeline, larger pipelines require the use of bigger equipment and more room to operate. The amount of workspace required is also dependent on the type of terrain being crossed and any special construction requirements.



The landowner is normally compensated a fair market value for the permanent easement, which while typically allows the landowner continued use and enjoyment of their property, but with some limitations. The limitations typically prohibit structures and trees within the easement in order to preserve safe access of maintenance equipment when necessary and allows for uninhibited aerial inspection of the pipeline system.

The landowner is generally compensated a lower value for the use of the temporary construction easement, since this land reverts back to the landowner after construction for their full use and enjoyment without any restrictions.

Additionally, landowners are compensated for any damages/losses they may incur as a result of the construction across their property, such as loss of crop revenues.

Sometimes, the landowner and the pipeline company may not be able to reach agreement on it. If the commission determines there is a public need for the pipeline, it will grant the pipeline company under eminent domain - the right of the government to take private land for public use, the same telecommunications companies, railroads and the transportation infrastructure in the U.S. It is important for pipeline projects, eminent domain applies only to the specific facilities and uses authorized by state or federal courts then supervise the fair compensation and treatment of the landowner.

Process is as follows:

- a) Natural Gas Act gives eminent domain authority if you get a certificate for a project, FERC does only the certificate that is needed for all the public good.
- b) Commission does not give access! You have to take your eminent domain rights to the court access to the property.
- c) The government does not take the private land - the laws of the country allow us the rights to

Pipeline Construction

A pipeline construction project looks much like a moving assembly line. A large construction project is divided into manageable lengths to be constructed by a fully equipped, highly specialized qualified work construction spreads. Each spread is composed of various crews, each with its own set of responsibilities. As one spread completes its work, the next crew moves into position to complete its piece of the construction project. A construction spread may be 30 to 100 miles in length, with the front of the spread clearing the right-of-way and restoring the right-of-way.

This schematic graphically illustrates the activities involved in a construction spread.



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Clearing & Grading

The survey crew carefully surveys and stakes the construction right-of-way to ensure that only the pre-approved construction workspace is cleared. The Clearing and Grading crew leads the construction spread. This crew is responsible for removing trees, boulders and debris from the construction right-of-way and preparing a level-working surface for the heavy construction equipment that follows. The crew installs silt fence along edges of streams and wetlands to prevent erosion of disturbed soil. Trees inside the right-of-way are cut down, and the contractor removes or stacks the timber along the side of the right-of-way for the landowner. Brush is commonly shredded or burned. As may be necessary for some projects in agricultural areas, topsoil may also be stripped to a predetermined depth and stockpiled along the sides of the right-of-way.



Stringing

Generally, the pipe is transported from the pipe mill to a pipe storage yard in the vicinity of the pipeline location. The pipe lengths are typically 40 to 80 feet long. A stringing crew using specialized trailers moves the pipe from the storage yard to the pipeline right-of-way. The crew is careful to distribute the various pipe joints according to the design plan since the type of coating and wall thickness can vary based on soil conditions and location. For example, concrete coating may be used in streams and wetlands, and heavy wall pipe is required at road crossings - and in special construction areas.



Trenching

The trenching crew typically uses a wheel trencher or backhoe to dig the pipe trench. The U.S. Department of Transportation requires the top of the pipe to be buried a minimum of 30 inches below the ground surface in rural areas, so the depth of the trench is at least five to six feet deep for pipe 30 to 36 inches in diameter. The pipe is buried even deeper at stream and road crossings.

If the crew finds large quantities of solid rock during the trenching operation, it uses

special equipment or explosives to remove the rock. The contractor uses explosives carefully, in accordance with state and federal guidelines, to ensure a safe and controlled blast.

In cultivated areas the topsoil over the trench is removed first and kept separate from the excavated subsoil, a process called topsoiling. As backfilling operations begin, the soil is returned to the trench in reverse order with the subsoil put back first, followed by the topsoil. This ensures the topsoil is returned to its original position.

Pipe Bending

The pipe bending crew uses a bending machine to make slight bends in the pipe to account for changes in the pipeline route and to conform to the topography.

The bending machine uses a series of clamps and hydraulic pressure to make a very smooth, controlled bend in the pipe. All bending is performed in strict accordance with federally prescribed standards to ensure integrity of the bend.

Welding

The pipe gang and a welding crew are responsible for welding, the process that joins the various sections of pipe together into one continuous length. The pipe gang uses special pipeline equipment called side booms to pick up each joint of pipe, aligns it with the previous joint and makes the first part (pass) of the weld. The pipe gang then moves down the line to the next section repeating the process. The welding crew follows the pipe gang to complete each weld. Depending on the wall thickness of the pipe, three or more passes may be required to complete each weld.

In recent years contractors have used semi-automatic welding units to move down a pipeline and complete the welding process. Semi-automatic welding, done to strict specifications, still requires qualified welders and personnel are required to set up the equipment and conduct hand welding at connection points and crossings.

As part of the quality assurance process, each welder must pass qualification tests to work on a particular pipeline job, and each weld procedure must be approved for use on that job both in accordance with federally adopted welding standards. Welder qualification takes place before the project begins. Each welder must complete several welds using the same pipe as that to be used in the project. The welds are then evaluated by placing the welded material in a machine and measuring the force required to pull the weld apart. It is interesting to note that the weld has a greater tensile strength than the pipe itself.

A second quality assurance test ensures the quality of the ongoing welding operation. To do this, qualified technicians take X-rays of the pipe welds to ensure the completed welds meet federally prescribed quality standards. The X-ray technician processes the film in a small, portable darkroom at the site. If the technician detects any flaws, the weld is repaired or cut out, and a new weld is made. Another form of weld quality inspection is one employing ultra sonic technology.

Coating

Line pipe is externally coated to inhibit corrosion by preventing moisture from coming into direct contact. Normally, this is done at the mill where the pipe is manufactured or at another coating plant located near the construction site.

All coated pipe, however, has uncoated areas three to six inches from each end to prevent interference with the welding process. Once the welds are made, a coating crew coats the field joint, the area between the two pipe sections.

the pipeline is lowered into the ditch.

Pipeline companies use several different types of coatings for field joints, the most common being polyethylene heat-shrink sleeves. Prior to application, the coating crew thoroughly cleans the pipe with a wire brush or sandblast to remove any dirt, mill scale or debris. The crew then applies the coating - a process that is completed prior to lowering the pipe in the ditch.

Prior to lowering the pipe into the trench, the coating of the entire pipeline is inspected to ensure no defects.

Lowering-In

Lowering the welded pipe into the trench demands close coordination and skilled operators. Using a series of side-booms, which are tracked construction equipment with a boom on the side, operators simultaneously lift the pipe and carefully lower the welded sections into the trench. Non-metallic slings protect the pipe and coating as it is lifted and moved into position.

In rocky areas the contractor may place sandbags or foam blocks at the bottom of the trench prior to lowering-in to protect the pipe and coating from damage.



Backfilling

Now that the pipe has been placed in the trench, the backfilling of the trench can begin. This can be accomplished with either a backhoe or padding machine depending on the soil makeup. As with previous construction crews, the backfilling crew takes care to protect the pipe and coating as the soil is returned to the trench. As the operations begin, the soil is returned to the trench in reverse order, with the subsoil put back first, followed by the topsoil. This ensures the topsoil is returned to its original position in areas where the ground is rocky and coarse, crews screen the backfill material to remove rocks, or bring in clean fill to cover the pipe or the pipe is covered with a material to protect it from sharp rocks. Once the pipe is sufficiently covered the coarser soil and rock can be used to complete the backfill.



Hydrostatic Test

After completion of the construction steps described above, but before the pipeline is put into natural gas service, the entire length of the pipeline is pressure tested using water. The hydrostatic test is the final construction quality assurance test. Requirements for this test are also prescribed in DOT's federal regulations. Depending on the varying elevation of the terrain along the pipeline and the location of available water sources, the pipeline may be divided into sections to facilitate the test. Each section is filled with water and pressured up to a level higher than the maximum pressure the pipeline will be operated at. The test pressure is held for a specific period of time to determine if it meets the design strength requirements and if any leaks are present. Once a test section successfully passes the hydrostatic test, water is emptied from the pipeline in accordance with state and federal requirements. The pipeline is then dried to ensure it has no water in it before gas is put into the pipeline.



Restoration

The final step in the construction process is restoring the land as closely as possible to its original condition. Depending on the requirements of the project, this process typically would involve decompacting the construction work areas, replacing topsoil, removing large rocks that may have been brought to the surface, completing any final

repairs to irrigation systems or drain tiles, apply lime or fertilizer, restoring fences, etc. The restoration crew carefully grades the right-of-way and in hilly areas, installs erosion prevention measures such as interceptor dikes, which are small earthen mounds constructed across the right-of-way to divert water. The restoration crew also installs riprap, consisting of stones or timbers, along streams and wetlands to stabilize soils. As a final measure the crew may plant seed and mulches the construction right-of-way, to ensure it is restored to its original condition.



SPECIAL CONSTRUCTION TECHNIQUES

Open Cut River and Stream Crossings

This crossing method involves excavating a trench across the bottom of the river or stream to be crossed with the pipeline. Depending on the depth of the water, the construction equipment may have to be placed on barges or other floating platforms to excavate the pipe trench. If the water is shallow enough the contractor can divert the water flow with dams and flume pipe to allow backhoes, working from the banks or the streambed, to dig the trench.



The contractor prepares the pipe for the crossing by stringing it out on one side of the stream or river and then welding, coating and hydrostatically testing the entire pipe segment. Sidebooms carry the pipe segment into the streambed, similar to construction on land, or the construction crew floats the pipe into the river with flotation devices and positions it for burial in the trench. Concrete weights or concrete coating ensures the pipe will stay in position at the bottom of the trench once the contractor removes the flotation devices.

Directional Drilling

Another crossing method is the use of directional drilling. While not always feasible, this method avoids the excavation of a trench across the bottom of the crossing. It is a method considered for longer crossings and requires special geological conditions at the crossing location. Basically, it involves drilling a hole large enough for the pipeline to be pulled through it and in the shape established by the designers.



Before a directional drill can be designed, core samples must be taken on both sides of the crossing to evaluate the underground rock and sand formations. If the subsurface will support a directional drill, the engineer can design a crossing that establishes the entry point, the exit point of the pipeline crossing and its profile as it would traverse under the crossing.



While this drilling is in progress, the line pipe sections are strung out on the far side of the crossing, to be welded. Once welded the joints are X-rayed, coated, hydrostatically tested and the preparation for being pulled back through the drilled out hole.

Once the drilling operation is complete the cutting head is removed and the drill string is attached segment. The crew uses the drilling rig to pull the pipeline segment back through the drilled hole.

connected into the pipeline on both ends.

Wetlands

"Pipelining" in wetlands or marshes requires another special construction technique. In one technique, crews place large timber mats ahead of the construction equipment to provide a stable working platform. The timber mats act much like snowshoes, spreading the weight of the construction equipment over a broad area. The mats make it possible to operate the heavy equipment on the unstable soils.



Road Bores

For crossing most small roads pipeline contractors use the "open-cut" method. Traffic is diverted, a trench is dug across the road and the pipeline is installed. The contractor subsequently repairs the pavement.

For highways and major roads with heavy traffic, pipeline contractors often use road bores. In a directional drill for river crossings, the road bore is accomplished with a horizontal drill rig, or a boring machine drills a hole under the road to allow insertion of the pipe. In some instances a casing is drilled the hole, and the gas pipeline is inserted inside the casing. The benefit of the road bore is that it allows pipeline installation without disrupting traffic.

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